IN THE CLAIMS:

1   1. (Previously Presented) A method for a storage operating system implemented in a

2   storage system to optimize an amount of readahead data retrieved from

3   a data container of the storage system, comprising:

4   managing a separate set of readahead metadata for each individual read stream of

5   a plurality of read streams, wherein the read stream is a set of one or more client read

6   requests to retrieve data from a contiguous range of file offsets within a requested file;

7   storing the separate set of readahead metadata in a corresponding individual

8   readset data structure for the each individual read stream;

9   maintaining, in the individual readset data structure, a plurality of factors for the

10   each read stream, the plurality of factors determining the amount of readahead data

11   retrieved from the data container <u>for</u> the one or more client read requests;

12   receiving a client read request associated with a particular read stream at the

13   storage system and determining an amount of readahead data to retrieve from the data

14   container for the particular read stream;

15   receiving a next client read request associated with the particular read stream;

16   locating a readset data structure for the particular read stream;

17   determining whether the storage operating system is permitted to retrieve

18   readahead data from the data container in response to the received next client read

19   request; and

20   if it is determined that the storage operating system is permitted to retrieve

21   readahead data from the data container, performing the steps of,

22   (i) modifying one or more of the plurality of factors stored within the readset data

23   structure for the particular read stream;

24   (ii) adjusting, in response to modifying the one or more factors, an amount of

25   readahead data to retrieve for the next client read request associated with the particular

26   read stream, wherein the amount of readahead data to retrieve for the next client read

27   request is different from the amount of readahead data retrieved for the client read

28   request;

29   (iii) retrieving the adjusted amount of readahead data from the data container; and

30   (iv) determining if the readset data structure meets a criteria for being updated,

31 and if the readset data structure meets the criteria then updating the readset data structure.

1 2. (Original) The method of claim 1, wherein the data container is a file, directory, vdisk

2 or lun.

1 3. (Original) The method of claim 1, wherein the storage operating system is determined

2 to be permitted to retrieve readahead data from the data container when the client-

3 requested data extends the read stream past a predetermined next readahead value.

1 4. (Original) The method of claim 3, wherein the predetermined next readahead value is

2 stored in a readset data structure associated with the read stream.

1 5. (Previously Presented) The method of claim 3, wherein the predetermined next

2 readahead value is updated based on a percentage of the adjusted amount of readahead

3 data.

1 6. (Previously Presented) The method of claim 1, wherein a read-access style associated

2 with the data container is one of the plurality of factors used to select the amount of

3 readahead data.

1 7. (Previously Presented) The method of claim 6, wherein the adjusted amount of

2 readahead data equals zero if the read-access style corresponds to a random read-access

3 style.

1 8. (Previously Presented) The method of claim 1, wherein a number of client read

2 requests processed in the read stream is one of the plurality of factors used to select the

3 amount of readahead data.

9. (Original) The method of claim 8, wherein the number of client read requests processed in the read stream is stored as a count value in a readset data structure associated with the read stream.

10. (Previously Presented) The method of claim 1, wherein the amount of client-requested data is one of the plurality of factors used to select the amount of readahead data.

11. (Previously Presented) The method of claim 10, wherein the adjusted amount of readahead data is set equal to a predetermined upper limit for large amounts of client-requested data.

12. (Previously Presented) The method of claim 1, wherein the adjusted amount of readahead data is doubled if the number of client read requests processed in the read stream is greater than a first threshold value.

13. (Original) The method of claim 1, wherein the client-requested data is identified as read-once data when either (i) the number of client read requests processed in the read stream is greater than a second threshold value or (ii) a set of metadata associated with the read stream indicates that the client-requested data is read-once data.

14. (Previously Presented) The method of claim 1, wherein the adjusted amount of readahead data is stored in one or more buffers enqueued on a flush queue, the flush queue being configured to reuse buffers after a predetermined period of time.

15. (Original) The method of claim 14, wherein the predetermined period of time equals two seconds.

1   16. (Previously Presented) An apparatus configured to implement a storage operating

2   system that optimizes an amount of readahead data retrieved from a data container of the

3   apparatus, comprising:

4   means for managing a separate set of readahead metadata for each individual read

5   stream of a plurality of read streams, wherein the read stream is a set of one or more

6   client read requests to retrieve data from a contiguous range of file offsets within a

7   requested file;

8   means for storing the separate set of readahead metadata in a corresponding

9   individual readset data structure for the each individual read stream;

10   means for maintaining, in the individual readset data structure, a plurality of

11   factors for the each read stream, the plurality of factors determining the amount of

12   readahead data retrieved from the data container for the one or more client read requests;

13   means for receiving a client read request associated with a particular read stream

14   at the storage system and determining an amount of readahead data to retrieve from the

15   data container for the particular read stream;

16   means for receiving a next client read request associated with the particular read

17   stream;

18   means for locating a readset data structure for the particular read stream;

19   means for determining whether the storage operating system is permitted to

20   retrieve readahead data from the data container in response to the received next client

21   read request; and

22   if it is determined that the storage operating system is permitted to retrieve

23   readahead data from the data container,

24   (i) means for modifying one or more of the plurality of factors stored within the

25   readset data structure for the particular read stream;

26   (ii) means for adjusting, in response to modifying the one or more factors, an

27   amount of readahead data to retrieve for the next client read request associated with the

28   particular read stream, wherein the amount of readahead data to retrieve for the next

29   client read request is different from the amount of readahead data retrieved for the client

30   read request;

31   (iii) means for retrieving the adjusted amount of readahead data from the data

32   container; and

33   (iv) means for determining if the readset data structure meets a criteria for being

34   updated, and if the readset data structure meets the criteria then updating the readset data

35   structure.

1   17. (Original) The apparatus of claim 16, wherein the data container is a file, directory,

2   vdisk or lun.

1   18. (Original) The apparatus of claim 16, wherein the storage operating system is

2   determined to be permitted to retrieve readahead data from the data container when the

3   client-requested data extends the read stream past a predetermined next readahead value.

1   19. (Previously Presented) The apparatus of claim 18, further comprising means for

2   updating the predetermined next readahead value based on a percentage of the adjusted

3   amount of readahead data.

1   20. (Previously Presented) The apparatus of claim 16, wherein the plurality of factors

2   used to select the amount of readahead data ~~includes~~ comprises at least one of:

3   (i) the amount of client-requested data,

4   (ii) a number of client read requests processed in the read stream, and

5   (iii) a read-access style associated with the data container.

1   21. (Previously Presented) The apparatus of claim 16, wherein the adjusted amount of

2   readahead data is doubled if the number of client read requests processed in the read

3   stream is greater than a first threshold value.

22. (Previously Presented) A storage system configured to optimize an amount of readahead data retrieved from a data container of the storage system, ~~the storage system~~ comprising:

a network adapter for receiving a client read request for a particular read stream;

a memory configured to store instructions for implementing a storage operating system that performs the steps of~~:~~

managing a separate set of readahead metadata for each individual read stream of a plurality of read streams, wherein the read stream is a set of one or more client read requests to retrieve data from a contiguous range of file offsets within a requested file;

storing the separate set of readahead metadata in a corresponding individual readset data structure for the each individual read stream;

maintaining, in the individual readset data structure, a plurality of factors for the each read stream, the plurality of factors determining the amount of readahead data retrieved from the data container <u>for</u> the one or more client read requests;

receiving a client read request associated with a particular read stream at the storage system and determining an amount of readahead data to retrieve from the data container for the particular read stream;

receiving a next client read request associated with the particular read stream;

locating a readset data structure for the particular read stream;

determining whether the storage operating system is permitted to retrieve readahead data from the data container in response to the received next client read request; and

if it is determined that the storage operating system is permitted to retrieve readahead data from the data container, performing the steps of,

(i) modifying one or more of the plurality of factors stored within the readset data structure for the particular read stream;

(ii) adjusting, in response to modifying the one or more factors, an amount of readahead data to retrieve for the next client read request associated with the particular read stream, wherein the amount of readahead data to retrieve for the next client read

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30 request is different from the amount of readahead data retrieved for the client read

31 request;

32   (iii) retrieving the adjusted amount of readahead data from the data container; and

33   (iv) determining if the readset data structure meets a criteria for being updated,

34 and if the readset data structure meets the criteria then updating the readset data structure.

1 23. (Original) The storage system of claim 22, wherein the data container is a file,

2 directory, vdisk or lun.

1 24. (Original) The storage system of claim 22, wherein the storage operating system is

2 determined to be permitted to retrieve readahead data from the data container when the

3 client-requested data extends the read stream past a predetermined next readahead value.

1 25. (Previously Presented) The storage system of claim 24, wherein the predetermined

2 next readahead value is updated based on a percentage of the adjusted amount of

3 readahead data.

1 26. (Previously Presented) The storage system of claim 22, wherein the plurality of

2 factors used to select the amount of readahead data ~~includes~~ comprises at least one of:

3   (i)   the amount of client-requested data,

4   (ii)   a number of client read requests processed in the read stream, and

5   (iii)   a read-access style associated with the data container.

1 27. (Previously Presented) The storage system of claim 22, wherein the adjusted amount

2 of readahead data is doubled if the number of client read requests processed in the read

3 stream is greater than a first threshold value.

1 28. (Previously Presented) A computer-readable media containing program instructions

2 executed by a processor, comprising:

3   program instructions that manage a separate set of readahead metadata for each

4   individual read stream of a plurality of read streams, wherein the read stream is a set of

5   one or more client read requests to retrieve data from a contiguous range of file offsets

6   within a requested file;

7   program instructions that store the separate set of readahead metadata in a

8   corresponding individual readset data structure for the each individual read stream;

9   program instructions that maintain, in the individual readset data structure, a

10   plurality of factors for the each read stream, the plurality of factors determining the

11   amount of readahead data retrieved from the data container for the one or more client

12   read requests;

13   program instructions that receive a client read request associated with a particular

14   read stream at the storage system and determining an amount of readahead data to

15   retrieve from the data container for the particular read stream;

16   program instructions that receive a next client read request associated with the

17   particular read stream;

18   program instructions that locate a readset data structure for the particular read

19   stream;

20   program instructions that determine whether the storage operating system is

21   permitted to retrieve readahead data from the data container in response to the received

22   next client read request; and

23   if it is determined that the storage operating system is permitted to retrieve

24   readahead data from the data container, program instructions that,

25   (i) modify one or more of the plurality of factors stored within the readset data

26   structure for the particular read stream;

27   (ii) adjust, in response to modifying the one or more factors, an amount of

28   readahead data to retrieve for the next client read request associated with the particular

29   read stream, wherein the amount of readahead data to retrieve for the next client read

30   request is different from the amount of readahead data retrieved for the client read

31   request;

32   (iii) retrieve the adjusted amount of readahead data from the data container; and

33   (iv) determine if the readset data structure meets a criteria for being updated, and

34   if the readset data structure meets the criteria then update the readset data structure.

1   29. (Original) The computer-readable media of claim 28, wherein the data container is a

2   file, directory, vdisk or lun.

1   30. (Previously Presented) The method of claim 1, wherein the retrieved readahead data

2   is stored in one or more buffers, the <u>one or more</u> buffers ~~containing~~ <u>comprising</u> a flush

3   queue, the flush queue being configured to reuse buffers after a predetermined period of

4   time.

1   31. (Previously Presented) The method of claim 30, wherein the read stream

2   corresponds to a read-once data transfer and data retrieved from the data container is

3   stored in the flush queue.

1   32. (Previously Presented) The method of claim 30, wherein the retrieved readahead

2   data is stored in the flush queue.

1   33. (Previously Presented) The method of claim 30, wherein one or more buffers

2   accessed from the flush queue are re-enqueued on a normal queue.

1   34-75. (Cancelled).